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AEROSOL LIMB ABSORPTION

Extract from Japanese Report, "Interim Report - EXOS-C Satellite," July 1982, pp. 29-36

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16. Abstract

A global observation was conducted of the vertical distribution of stratospheric aerosol and ozone using the absorption effect of the rays of the sun by the stratospheric aerosol and ozone.

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1.3.1 Purpose

The purpose of this study is to conduct a global observation of the vertical distribution of the stratospheric aerosol and ozone at the altitude resolution of 1 Km by utilizing the absorption effect of the rays of the sun by the stratospheric aerosol and ozone. The observation is to be conducted at sunrise and sunset when the absorption is the greatest. The following items are expected to be elucidated by this global monitoring.

(1) Quantative evaluation of influences of human activities upon the aerosol and ozone.

(2) Examination of the changes in these substances by natural disturbances such as volcanic eruptions or solar activities.

(3) Uncovering of the actual state of transit of the atmospheric circulation by covering broad areas, and also by conducting the observation for a long period of time.

1.3.2 The method of observation

Fig 1 is a conceptional diagram of the method of observation. The opitical thickness r(h) of the atmosphare along the passage of sun rays can be obtained by the ratio between the intensity of solar beams at the time of high solar altitude I_0 (Weakening of the intensity at this time should be considered nonexistent) and the intensity of solar beams at the time when the zenith angles have exceeded 90 degrees and the beams has reached the satellite through the outer edge of the earth atmosphare with the altitude indicated by h. The r(h) is an integral figure of a coefficient of extinction β(h) along the passage of the beams. Therefore, β(h) can be figured by the inverse conversion of r(h), assuming an evenly stratified horizontal distribution.

1.3.3 Observational instruments

(a) Optical and electric

The measuring instrument is a 2 channel radio meter to measure the intensity of solar beams with two wavelength - 600nm(for ozone), and 1μm(for aerosol). In order to measure aerosol and ozone at the altitude resolution of 1 Km, it is not sufficient to measure the changes in the intensity of solar beams as a whole; the solar surface must be subdivided, and the intensity from the each subdivided section of the solar surface must be measured. For this reason, solar beams which passed through the nutral filter and the interference filter are condensed by the f-80 mm condensing lens, reflected on the CCD image sensor placed at the focal plane. Using the CCD the image of the sun is subdivided; the intensity of each segment is measured. CCD uses two dimentional data that have 380(V)x488(H) imagery data by the Fairchild Corporation. The size of the beam reception plane is 8.8 mm(V) x 11.4 mm(H); the field of vision with f-80mm lens is approximately 6 degrees. This is within the precision of satellites' attitude control system as expected. Fig 2 shows the entire measuring device.

(b) Imagery management and data format

The image of the sun becomes flat as it approaches nearer to the earth due to an atmospheric refraction as shown in Fig 3. The imagery can be easily managed if the direction of the horizontal scanning of the CCD imagery sensor and the earth horizon are joined together; the amount of required data become relatively small. However, in the case of EXOS-C, the axis of the satellite points toward the sun and the phase angle around it is not fixed. In other words, the direction of the imagery sensor horizontal

scanning and the earth horizon form a certain degree of angle. For this reason, the ALA is provided with the following measures so that the imagery of the sun will reemerge with a limited data transmission speed.

(I) A threshold level of light Vo is given.

(II) During the scanning of the imagery sensor horizontal line, the horizontal position IS-1 of the very first data exceeding Vo, and its vertical position JS are counted.

(III) When the data signal on the same horizontal line becomes below Vo, its horizontal position 1E-1 is counted.

(IV) The intensity of the tenth data from IS-1 , DATA-1, is measured.

(V) In the same manner, IS-2, DATA-2; IS-3, DATA-3; IE-3...are measured.

(VI) Finally, after the tenth measurement without any one of the signal exceeding Vo, the scanning of the solar surface is considered completed; the vertical position is designated as JE.

(VII) CCD image sensor used now is of interlace method, i.e. the horizontal lines are scanned in the order of an odd number, an even number (1,3,5,...) (2,4,6,...). Accordingly, after conducting (I)-(VI) operations on odd number lines, the same is conducted on even number lines independently. In this manner, a set of one channel imagery management is completed.

(VIII) The operations (I) through (VII) are conducted for the second channel, a channel of different wavelength. In this manner, a complete data of a set,1 and 2 channel,is obtained.

The time needed to complete the operations (I) through (VIII) and write data is 5 seconds. Considering the average speed of sunrise and sunset - the minimum of nine seconds to advance the sunrise and sunset equal to the diameter of the image of the sun - information from each altitude can be obtained from more than two records. Data is recorded in W72 - W79.

The concrete data format is shown in Fig 4. The first four bits are used to identify the channel number and the odd-even differences of the numbers. As the image of the sun reemerge based on data from (I) - (VIII), the other data, the horizontal inclination obtained from the horizon sensor, become necessary.

(c) Planned electric power, weight

+12V.......1000mW

-12V.......1000mW

+5V.......2500mW

Total 4500mW (Average figure)

Weight.....3.28Kg

1.3.4 Command

Discrete command SEE page 9 "Discrete command"

OG Command SEE page 9 "OG command"

MODE 1,2,3,7,8,10 ALA ON

MODE 4,5,6,9,11,13,14,15 ALA OFF

Explanation of discrete command

1, 2: ALA switch is ON, off

9,10: Determine the measuring device either

Cal mode or meas. mode.

3-8: ALA conducts digital management of the solar imagery. In order to distinguish between optical signal and noise signal, a threshold level of the comparator must be set. The threshold level must be set high when the noise level is high due to the higher temperature of the measuring device; it must be set low when the noise level is low due to the lower temperature of the device. This command sets the level considering the ALA data and temperature. 3-5 is the channel 1, in other words, λ=600nm; 6-8 is the channel 2, in other words, λ=1 μm. The levels are changed from the low to high in the order of 1, 2, 3. The concrete setting of the temperature - level relationship must wait until the completion of environmental experimentations.

11, 12: CCD sensor output is in the form of video signal. This is the command to change amplification rates. The changes are uniform in both the first and the second channel; no individual control. Two "Gain" are set for 1 and 2. Once this is set at the early stage of the operation, it seems that later changes are unnecessary.

Seizure of the command responce

Command responce is indicated in W-94.

Contents of W-94

| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | (bit)
←---A-----→←B→←-TEL--→←C→←TEL→

A: the 1st - the 3rd bit

CH1

0	00	Threshold level 1 of CH1
0	10	Threshold level 2 of CH1
0	11	Threshold level 3 of CH1

CH2

0	00	Threshold level 1 of CH2
0	10	Threshold level 2 of CH2
0	11	Threshold level 3 of CH2

B: The 4th bit Cal
1 ON
0 OFF

C: The 7th bit Gain
1 1
0 2

D: The 5th, 6th and 8th bit are used by TEL.

1.3.5 HK item

F NO	Item Cont.	Meas.
F64n + 34	ALA ozone sensor temp.	-50C to 70C
F64n + 35	ALA aerosol sensor temp.	-50C to 70C

.LI1

1.3.6 Employment

10 to 15 minutes at sunrise and sunset

Occacionally, a few minutes up to ten minutes of reference signal collection during sunlight hours.

The only meaningful data is during the period of high bit rate.

Therefore, measuring by high bit rate is done for10 to 15 minutes at sunrise and sunset; the other measurements are done by low bit rate.

Fig 1

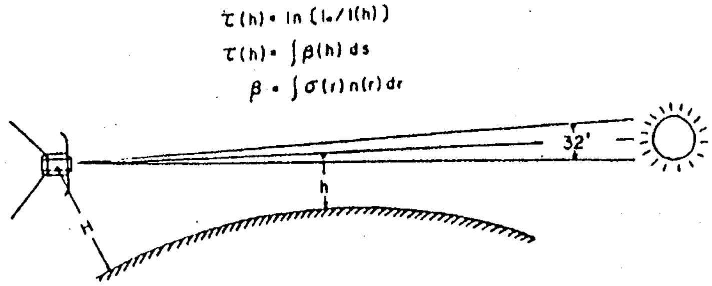

図 1

Fig 2

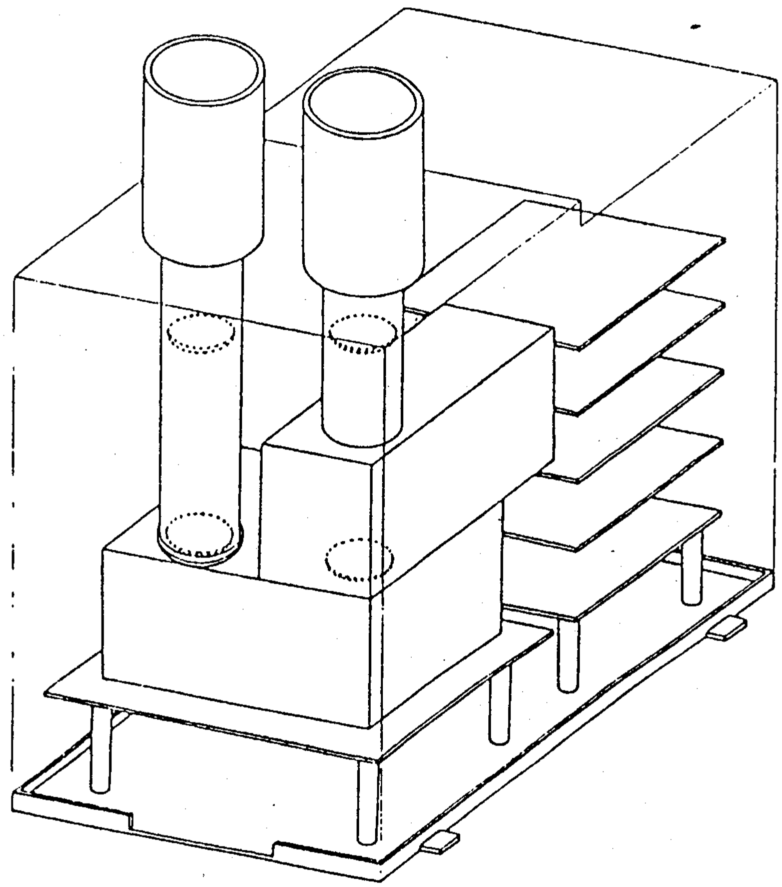

図 2

Fig 3

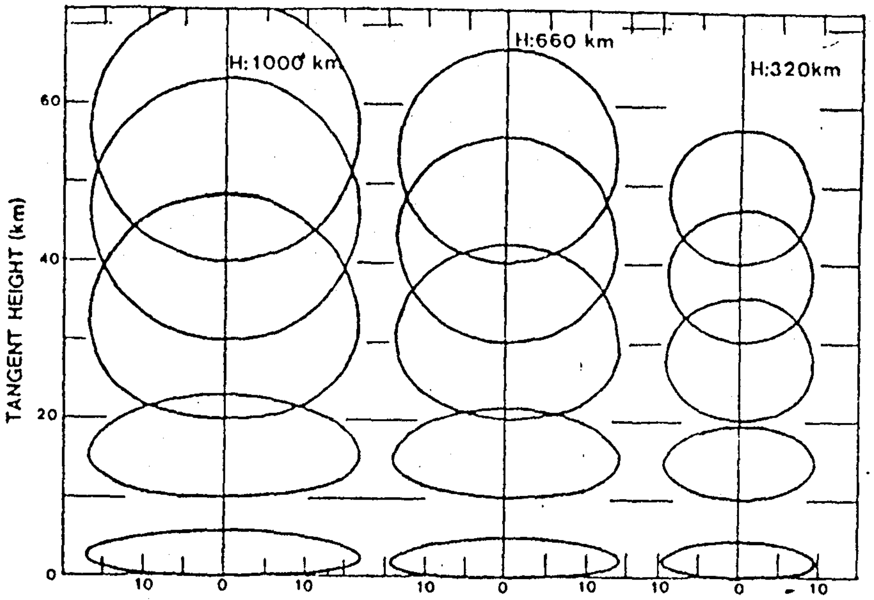

図 3

Discrete command

種別		項目	DDC		用途
①	B	ALA ON	4	13	ALA 電源ON
②	B	ALA OFF	4	14	ALA 電源OFF
③	A	ALA, CH-1 LEVEL-1	5	13	ALA チャンネル1 コンパレーターレベル1 設定
④	A	ALA, CH-1 LEVEL-2	6	13	ALA 〃 2 〃
⑤	A	ALA, CH-1 LEVEL-3	4	15	ALA 〃 3 〃
⑥	A	ALA, CH-2 LEVEL-1	5	14	ALA チャンネル2 コンパレーターレベル 1 〃
⑦	A	ALA, CH-2 LEVEL-2	6	14	〃 2 〃
⑧	A	ALA, CH-2 LEVEL-3	7	14	〃 3 〃
⑨	B	CAL ON	1	16	校正 ON
⑩	B	CAL OFF	1	17	校正 OFF

種別		項目	PDC		用途
			V	H	
⑪		ALA GAIN-H	13	7	ALAハイゲイン設定
⑫		ALA GAIN-L	14	7	ALAローゲイン設定

O.Gコマンド

Fig 4

W72	W73	W74	W75	W76	W77	W78	W79

CH-1 ODDの識別⑮	1111	JS	IS-1	IE-1	DATA-1	IS-2	IE-2
	0010	DATA-2	IS-3	IE-3	DATA-3	IS-4	IE-4
	0011	DATA-4	IS-5	IE-5	DATA-5	IS-6	IE-6
CH-1 ODD	0100	DATA-6	IS-7	IE-7	DATA-7	IS-8	IE-8
	0101	DATA-8	IS-9	IE-9	DATA-9	IS-10	IE-10
	0110	DATA-10	IS-11	IE-11	DATA-11	IS-12	IE-12
	0111	DATA-12	IS-13	IE-13	DATA-13	IS-14	IE-14
	1000	DATA-14	IS-15	IE-15	DATA-15	IS-16	IE-16
	1001	DATA-16	IS-17	IE-17	DATA-17	IS-18	IE-18
	1010	DATA-18	IS-19	IE-19	DATA-19	0000000000	JE

CH-1 EVENの識別⑭	1110	JS	IS-1	IE-1	DATA-1~	IS-2	IE-2
	0010	DATA-2	IS-3				
	0011						
CH-1 EVEN	0100						
	0101						
	0110						
	0111						
	1000						
	1001						
	1010					0000000000	JE

CH-2 ODDの識別⑬	1101	JS					
	0010						
	0011						
CH-2 ODD	0100						
	0101						
	0110						
	0111						
	1000						
	1001						
	1010					0000000000	JE

CH-2 EVENの識別⑫	1100	JS					
	0010						
	0011						
CH-2 EVEN	0100						
	0101						
	0110						
	0111						
	1000						
	1001						
	1010					0000000000	JE

識別4bit

図 4